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Pocket Guide to Red Pine Diseases and Their Management

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PESTICIDE PRECAUTIONARY STATEMENT

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INTRODUCTION

Red pine (*Pinus resinosa* Ait.) is one of our most valuable tree species. Therefore, it is imperative for land managers to be familiar with red pine diseases that have the potential to cause major economic losses. This knowledge combined with adequate dollars, teamwork, early detection, positive pest identification, and proper timing, selection, and applications of available controls, can help prevent or reduce disease impact.

The range of red pine extends from Newfoundland and Quebec west to Ontario and southwestern Manitoba, south to northeastern Minnesota, northern Pennsylvania, New York, Connecticut, and Maine. It is also found in scattered locations in northeastern Illinois and West Virginia. A century ago red pine made up about a third of the 22 million acres of pine forests in the Lake States of Minnesota, Wisconsin, and Michigan, but today it covers a little more than 1 million acres (Benzie 1977). Red pine commonly grows in association with jack pine (*P. banksiana* Lamb.) and white pine (*P. strobus* L.) but also occurs as scattered individual trees in hardwood stands. It thrives on a variety of sites but is intolerant of shade and grows best in even-aged stands.

Red pine provides many useful products such as pulpwood, poles, posts, cabin logs, piling, sawtimber, and veneer. To help meet projected needs for softwood, modern forest managers are relying more and more on intensive plantation culture for the efficient production of wood. Because of red pine's fast growth, high productivity, and high economic value, it has been recommended that forest managers restore red pine to several million acres of commercial land that converted to other cover types after the original pine logging (Benzie 1977). Developing red pine plantations on suitable sites is one of the most productive ways of using certain land. As recently as 1982, red pine accounted for 88 percent of the conifer acreage being planted in the Lake States by pulp and paper companies and for 57 percent of conifer acreage planted

by state and federal agencies. The predominance of red pine is of concern to some forest managers and pest control specialists. Red pine was once considered to have few serious enemies, but several diseases and insects have recently damaged or killed trees (Nicholls 1979). To further compound this problem, red pine is known to have little genetic variation and is one of the most homogeneous pine species studied (Fowler and Lester 1970). Therefore, when a pest outbreak on red pine does occur, there is often little resistance to the attack. Attempts to introduce genetic variability into red pine by crossing it with other pines have led to the conclusion that strong genetic barriers, biochemical barriers, or both exist in red pine (Burchert 1979). Under these circumstances, breeding red pine for pest resistance would probably not pay off. But a forest manager can take several actions to prevent or reduce the impact of disease attack on red pine.

The objective of this paper is to provide forest managers and pest control specialists with management strategies and technical references for the most important diseases of red pine. Described on the following pages are the common disease problems of red pine. Learning to identify these diseases is the first step in prevention and control.

MAJOR DISEASES OF RED PINE

Disease

***Armillaria* shoestring root rot** caused by the fungus, *Armillaria obscura*, a part of the complex of *Armillaria* species.

Importance

This fungus is common throughout the Lake States in red pine plantations. Damage is especially severe on trees under stress and trees growing in cutover hardwood stands. *Armillaria* causes a decay, seldom extending more than a few feet above ground. It kills trees by girdling at the root collar.

Figure 1

Biology

Armillaria usually lives as a saprophyte and obtains its food from dead stumps and roots and the heartwood of living trees. But it may also live in roots as a parasite on living tissue. The disease causes abrupt or gradual reduction in growth, yellowing and then browning of foliage of the entire tree, and finally, death (fig. 1). Resin exudate

Figure 2

may be present on roots or near the root collar. Veined, white mycelial fans form between the bark and wood at the ground line where the cambium has been killed (fig. 2). Black fungal strands (fig. 3) (rhizomorphs) also form on tree roots, on or under the bark, or in severely decayed wood. These strands may radiate into the soil where they may cause infection if they come in contact with the roots of other red pine. Honey-colored mushrooms form on the lower trunk of dead or dying trees usually in the fall (fig. 4). The fungus may spread either by windborne spores produced by the mushrooms or, more commonly, by rhizomorphs. The fungus may also spread from infected tissue to living trees through root contact.

Management Guidelines

Preventive measures that maintain conditions favorable for rapid and vigorous tree growth will usually minimize the impact of this disease.

- Choose a site well suited for red pine to maintain healthy, vigorous trees. This reduces stress and trees will be more resistant to *Armillaria* infection.
- Avoid planting on cutover sites, especially those with many hardwood stumps that serve as an *Armillaria* reservoir.
- If practical, remove dead trees, and infected stumps and large roots before planting red pine. These items can serve as a source of *Armillaria* for at least 10 years after the tree dies. This is also true of herbicide-killed trees.

Technical References

Leaphart, C.D. 1963. Armillaria *root rot. For. Insect and Dis. Leafl. 78. Washington, DC: U.S. Department of Agriculture, Forest Service. 8 p.*

Pronos, T.; Patton, R.F. 1977. Armillaria *root rot of red pine planted on oak sites in Wisconsin. Plant Disease Reporter. 61: 955-958.*

Pronos, T.; Patton, R.F. 1978. Penetration and colonization of oak roots by Armillaria mella *in Wisconsin. European Journal of Forest Pathology. 8: 259-267.*

Whitney, R.D. 1988. Armillaria *root rot in softwood plantations in Ontario. Forest Chronicle. 64: 345-351.*

Figure 3

Figure 4

Pine needle rust

Disease

Pine needle rust caused by the fungus, *Coleosporium asterum*.

Importance

Needle rust is most prevalent on young trees up to sapling size throughout the Lake States (fig. 5). The disease does not usually seriously damage trees. But in high hazard sites, where abundant goldenrod and big leaf aster can serve as the alternate host for the rust, the foliage is often killed. This causes reduced tree growth and unsightly foliage. Needle rust, when combined with insects or other agents that attack current-year shoots, can kill small trees.

Figure 5

Biology

This fungus needs both pine and goldenrod or aster to complete its 1-year life cycle. Windborne spores (aeciospores) erupt from orange blisters on the pine needles (fig. 7). These infect alternate hosts during early summer. Windborne spores (sporidia) produced on the alternate hosts infect pines in late summer (fig. 6). Needle rust overwinters in pine needles and produces spores the next spring, completing the life cycle.

Figure 6

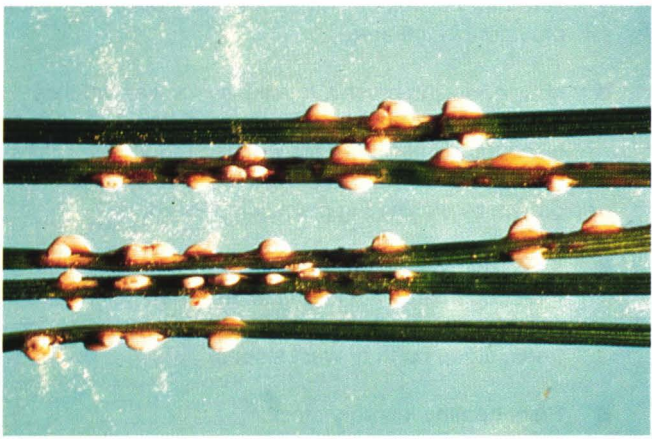

Figure 7

Management Guidelines

Control of this disease may be desirable in young or newly established Christmas tree plantations, in nurseries, or in other high-value stands that are severely infected. Here are some controls that will help reduce the impact of the disease under such conditions:

- Avoid planting sites or nursery locations where goldenrods and asters grow abundantly.
- Before August, kill goldenrods or asters concentrated within 1,000 feet (305 m) of nurseries and young newly established plantations by applying an herbicide registered for such use.
- Mow goldenrods and asters before August to avoid using an herbicide. This method does not kill the plants and would have to be done each year until the tree crowns shade out the herbaceous cover.
- Establish barriers 16 to 26 feet (5 to 8 m) tall of non-susceptible plants to intercept spores and to change air currents between pine and the adjacent alternate host. This helps reduce the number of spores reaching pine needles.
- Plant conifers that are resistant to *Coleosporium* needle rust, such as white, Norway, blue, and black spruce, white pine, and balsam fir, where it is impossible to control alternate hosts. However, be sure other diseases that attack these species are not prevalent in the area.
- Mow or poison brushy, tall grassy, or weedy fields before August to reduce moisture on local sites and discourage infection. This will also reduce spore production on alternate hosts and accelerate pine growth by eliminating plant competition.
- Avoid humid planting sites for pine such as: small forest openings with diameter less than height of surrounding trees, sites north or west of a stand of tall trees, steep north or west slopes.
- Plant healthy nursery stock.

Technical References

Nicholls, T.H.; Patton, R.F.; Van Arsdel, E.P. 1968. Life cycle and seasonal development of Coleosporium *pine needle rust in Wisconsin. Phytopathology. 58 (6): 822-829.*

Nicholls, T.H.; Anderson, R.L. 1976. How to identify and control pine needle rust disease. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 8 p.

Lophodermium needlecast

Disease

***Lophodermium* needlecast** caused by the fungus, *Lophodermium seditiosum* (formerly *L. pinastri*).

Importance

This fungus is of primary importance in nurseries throughout the Lake States where it defoliates and often kills many nursery seedlings (fig. 8).

The fungus can be transported on nursery stock to field locations where symptoms develop. The browning of infected seedlings after spring field planting has been confused with storage or handling problems or problems that originate in the field. Seedlings that survive in the field normally do not suffer major damage in later years. An unidentified *Lophodermium* sp. also attacks older foliage of sapling and pole-sized stands, but the importance of this fungus on reducing fiber production has not been determined.

Figure 8

Biology

Lophodermium spores are released from black fruiting bodies on dead needles during moist weather from August to October (fig. 9). The spores (ascospores) are disseminated by the wind and infect needles during this period. The fungus overwinters in attached or cast pine needles. In spring the fungus continues its development in pine needles and eventually kills them. The infected foliage (fig. 10) turns brown in May and June and falls off during the summer. Fruiting bodies develop on these infected brown needles by the end of July, completing the life cycle.

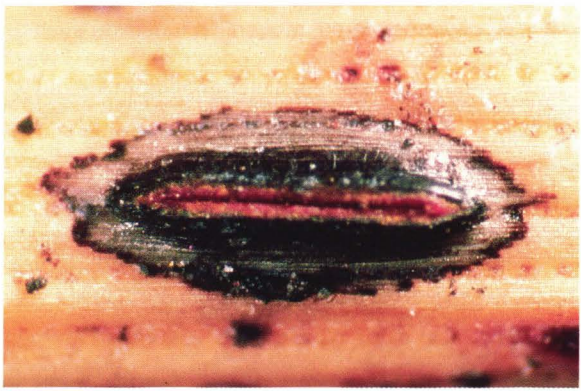

Figure 9

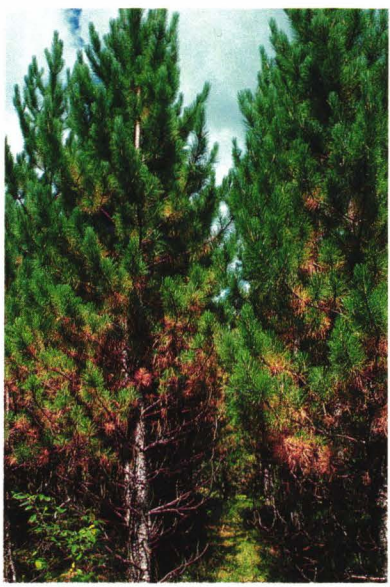

Figure 10

Management Guidelines

This disease must be controlled in the nursery so that infected stock is not shipped to the field. Figure 11 shows green seedlings that had been treated with a preventive fungicide and brown, untreated seedlings.

Nurseries

- Irrigate nursery seedlings in the morning so they have time to dry in the afternoon. This will avoid prolonged periods of moisture that favor *Lophodermium* infection.
- Do not ship infected nursery stock to the field.
- Apply a registered, preventive fungicide such as chlorothalonil or maneb, once every 2 to 3 weeks during the major infection period from late July through October. Apply more frequently if wet weather persists.
- Do not grow seedlings next to red or Scotch pine windbreaks that can serve as a *Lophodermium* inoculum source.

Figure 11

Field

- Plant only *Lophodermium*-free stock. If you suspect infection, have seedlings examined by a pest specialist.

Technical References

Nicholls, T.H.; Brown, D.H. 1975. How to identify Lophodermium *and brown spot diseases on pine. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 5 p.*

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Physiological needle droop

Disease

Physiological needle droop of red pine.

Importance

Young trees growing in low areas, on droughty soils, with heavy competition, or with J-rooting are periodically severely affected in the north-central to northern Lake States area. Damage is greatest on the shoots towards the tops of the seedlings, but lower branches can also be affected. If many buds are damaged, very small seedlings may die. Surviving trees may have some growth loss and stem deformity.

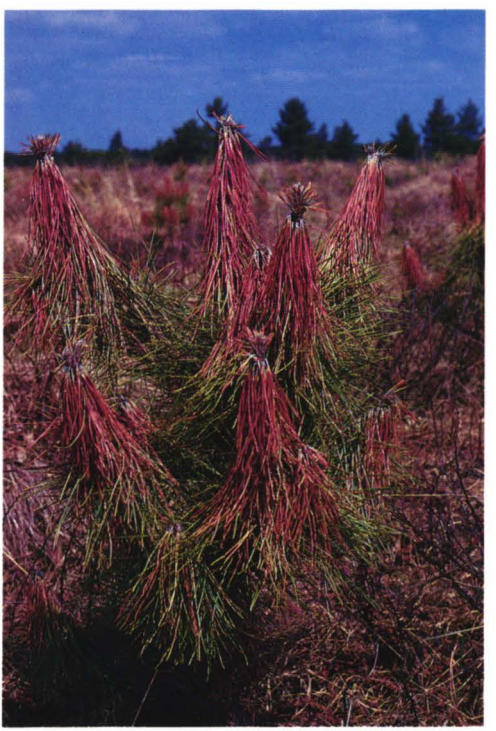

Figure 12

Biology

Physiological needle droop is caused by an abiotic disease. Usually trees under 7 feet (2 m) tall are affected in July and August on sites that have limited water available on hot, sunny, and windy days when transpiration is rapid. It only takes a few hours for needle tissue under the sheath to collapse due to lack of sufficient water. The needles droop and die (fig. 12), but they remain green for awhile. They gradually fade to brown over winter and stay on the tree into the next summer. Usually the buds remain alive and will expand, but most of the buds on severely damaged shoots will die. The remaining live buds will develop, and the tree will develop a bushy appearance.

Management Guidelines

- Avoid planting red pine on droughty sites.
- Plant carefully to avoid J-rooting.
- Control weed competition.
- Correctively prune trees. This will be required during stand improvement operations on seedlings and saplings with severe stem deformity.

Technical References

Bergdahl, D.R; French, D.W. 1976. Needle droop: An abiotic disease of plantation red pine. Plant Disease Reporter. 60: 472-476.

Patton, R.F.; Riker, A. J. 1954. Needle droop and needle blight of red pine. Journal of Forestry. 52: 412-418.

Scleroderris canker

Disease

Scleroderris canker caused by the fungus, *Gremmeniella abietina.*

Importance

Scleroderris canker has killed many trees in conifer plantations and forest nurseries in the northern areas of the Lake States. The fungus can be transported on nursery stock to field locations where new pockets of infection develop. Two strains of the fungus are known in North America.The North American strain, present in scattered locations in the northern Lake States and Northeastern States, attacks young trees but does little damage to trees taller than 7 feet (2 m) (fig. 13). The European strain has been found in several New England States where it has killed many trees of all ages in red pine plantations (fig. 14). The European strain is an extremely serious hazard to pine forests. Because of this potential hazard, forest managers in the Lake States need to know how to avoid major losses from this disease.

Figure 13

Biology

In the North American strain, primary infection is by windblown spores (ascospores). These are disseminated during moist weather from April to October; the major spore discharge and infection are in June and July. The spores infect through buds or needles, and infected branch tips usually die by the following summer. A characteristic symptom during May and June is an orange discoloration at the base of otherwise green needles (fig. 15). The fungus may grow down the branch and into the main stem of the tree where a canker commonly forms (fig. 16). The stem of a young seedling is quickly girdled, and the tree is killed.

Figure 14

A few months after an infected branch dies, fruiting bodies (pycnidia) appear near the base of dead needle fasicles. Asexual spores (conidia) ooze out of these pycnidia during wet weather from April to October. These spores are transported by rain splash and wind to nearby branches, spreading the infection in individual trees and onto adjacent trees. Fruiting bodies (apothecia) appear in early summer on branches that have been dead for 1 to 2 years (fig. 17). The apothecia are also commonly found at the base of dead needle fasicles and are often found in association with the pycnidial stage.

In the European strain, the windblown ascospore stage is rarely found and the infection period of the conidial spore stage is longer than in the North American strain, making it more difficult to control.

Figure 15

Figure 16

Figure 17

Management Guidelines

The best way to prevent the introduction of the dangerous European strain into the Lake States is to make sure that infected nursery stock, Christmas trees, or other infected material is not introduced.

Nurseries

- Do not ship infected nursery stock to the field. This will prevent the establishment of new infection centers.

- Protect red pine nursery stock where there is a potential Scleroderris canker hazard. The fungicide chlorothalonil is registered for nursery use and has proved effective. Apply the fungicide every 10 to 14 days during the major infection period in May or June. Some infection may occur at other times during the growing season, and nursery managers wanting to produce disease-free stock should keep a protective fungicide on seedlings from early spring until the seedlings are covered with snow in late fall.

- Remove infected trees within 2,200 feet (700 m) of nursery beds to reduce chances of stock becoming infected from windblown fungus spores.

- If possible, produce red pine nursery stock in areas where Scleroderris canker is absent.

- Avoid planting red pine seedlings adjacent to infected pine windbreaks.

Field

- Pick red pine planting sites where Scleroderris canker is not present.

- If the planting site is in a Scleroderris canker hazard area, select a species for planting that is immune or has a low susceptibility. Hard pines are highly susceptible, but spruces, cedars, firs, and larches are more resistant to infection.

- Avoid geographic depressions, such as frost pockets, where the disease is most damaging.

- Select planting stock from a nursery outside of the range of Scleroderris canker or from a nursery that has an effective fungicide control program.
- Do not plant infected seedlings.
- In high-value stands, prune lower branches on infected and healthy trees.
- Do not ship infected red pine Christmas trees into areas where Scleroderris canker is not present.
- Abide by all quarantine laws designed to prevent the introduction of the European strain into areas where it is not present.

Technical References

Dorworth, C.E. 1979. Stand reduction of red pine by Gremmeniella abietina. *Canadian Journal of Forest Research. 9: 316-322.*

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Sirococcus shoot blight

Disease

Sirococcus shoot blight caused by the fungus, *Sirococcus conigenus* (formerly *Sirococcus strobilinus*).

Importance

In the United States, Sirococcus shoot blight has become increasingly important since the early 1970's. When favorable conditions for infection have occurred, shoot and tree death have risen steadily in several local areas in the northern Lake States. Tree mortality in some Wisconsin red pine plantations, for example, increased from 19 to 67 percent from 1972 to 1976. Small seedlings and saplings growing under or near infected overstory trees are commonly killed by multiple infections (fig. 18). Trees not killed often became misshapen. Lower branches are often killed on pole-sized or larger trees as a result of multiple infections (fig. 19).

Figure 18

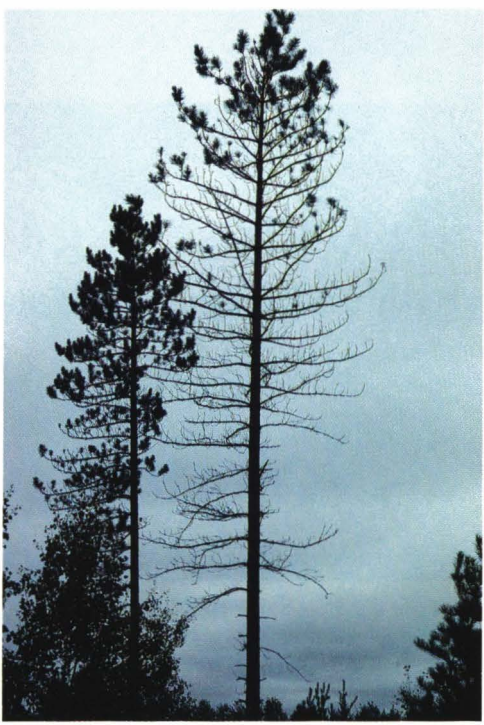

Figure 19

Sirococcus shoot blight

Biology

Initial infection occurs in juvenile needles and spreads into the stem to form a canker. A small drop of resin is often exuded at the base of the infected needle. The fungus spreads within the succulent stem tissue, but rarely into older wood. When infection occurs in the area of elongation, the restricted growth in the cankered area causes the shoot tip to curl over and form a crook (fig. 20). As the canker matures, small black fruiting bodies (pycnidia) form on dead needles under the fascicle and on shoots (fig. 21). These fruiting bodies produce large numbers of spores (conidia) that are spread to nearby red pine by rain splash. Under high humidity, mild temperatures, and low light, the spores germinate and infect red pine.

In the Lake States and the Northeastern States, major spore release and infection of current-year red and jack pine shoots occur in May and June. Symptoms such as pitch droplets, browning at the base of needles, chlorosis, shoot curling, shoot death, and needle droop (fig. 22) occur in late June, July, and August. The fungus overwinters in these dead shoots, and mature spores are produced and disseminated during rainy weather the following May and June, thus completing the life cycle.

Figure 20

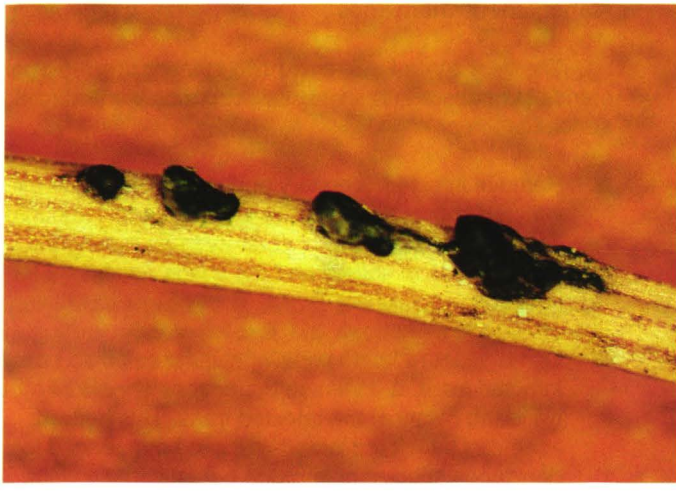

Figure 21

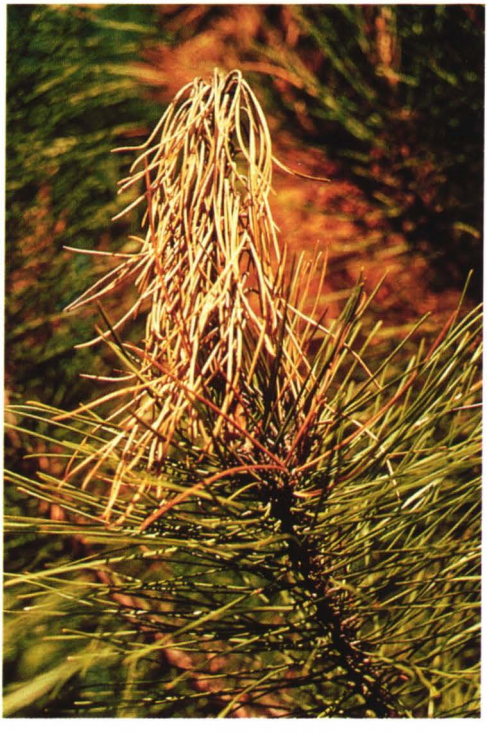

Figure 22

Management Guidelines

The best control is to avoid two-story or uneven-age stands in northern areas where *Sirococcus* is a potentially serious problem.

- Remove infected overstory and understory trees (or infected shoots if understory trees are small enough). The removal of infected overstory trees removes a major inoculum source and the shade necessary for infection.

- Do not plant red pine seedlings under or adjacent to infected trees. A minimum buffer zone should be twice the height of the infected trees. This buffer zone can be left unplanted or it can be managed for deciduous species or immune or resistant conifers, such as white spruce, black spruce, balsam fir, or larch. As a precaution, newly established red pine plantations should be checked 5 years after planting to make sure the fungus has not spread into the plantations. If the fungus is present, carry out appropriate control measures to ensure that major inoculum sources are eliminated.

- Remove small pockets of infection in an otherwise healthy plantation by cutting infected overstory and understory trees. This procedure will minimize *Sirococcus* damage to the remaining healthy stand.

- Avoid microclimatic conditions favorable for infection in *Sirococcus* hazard areas. Humid, shady planting sites, such as small forest openings (diameter less than height of surrounding trees); shaded sites north and west of a stand of tall trees; and steep north or west slopes are potential hazard areas and should not be planted with red pine.

- Manage for resistant or immune conifers or deciduous species in high *Sirococcus* hazard areas where removal of scattered infected overstory red pine is impractical. Before choosing an alternate species for planting, make sure other important diseases and insects of the chosen species are not prevalent in the area.

Technical References

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Sphaeropsis shoot blight and canker

Disease

Sphaeropsis shoot blight and canker caused by the fungus, *Sphaeropsis sapinea* (formerly *Diplodia pinea*).

Importance

Sphaeropsis causes shoot blight and stem canker of red pine in nurseries (fig. 23), plantations, windbreaks (fig. 24), and ornamental plantings throughout the Lake States. Although *Sphaeropsis* may attack healthy trees, the fungus usually attacks trees stressed by one or more or the following factors: poor site, drought, hail damage, snow damage, mechanical wounds, and insect activity. *Sphaeropsis* kills trees by killing the new foliage year after year or by initiating girdling stem cankers on stressed or injured trees.

Figure 23

Figure 24

Biology

Shoot blight (fig. 25) and branch and stem cankers (fig. 26) are the most common symptoms of *Sphaeropsis*. Shoot blight is common on trees of all ages, but cankers are more prevalent in saplings and pole-sized trees than in large trees. All symptoms are generally characterized by conspicuous amounts of resin. *Sphaeropsis* overwinters as mycelium or fruiting bodies in shoots, bark, cones (fig. 27), or litter. Spores (conidia) are disseminated during wet weather in spring through fall. Peak spore production and infection usually coincide with host bud break and shoot and needle elongation. The fungus first invades and kills succulent shoot tissue and then forms fruiting bodies on dead tissues (fig. 28). Spores from current-year infections may be disseminated in the same year or the following year. Infection can also occur through wounds caused by various agents such as hail and insect feeding. The fungus invades woody tissue under such conditions.

Figure 25

Management Guidelines

Prevention is the best way to control *Sphaeropsis*.

- Avoid planting red pine in areas where *Sphaeropsis* has been a problem.
- Do not plant red pine on poor sites, particularly sites subjected to periodic severe droughts.
- Prevent logging or other wounds, particularly during peak spore dispersal (May through August).
- Avoid planting red pine seedlings adjacent to infected conifer windbreaks.
- Do not shear infected Christmas trees while foliage is wet to avoid transferring *Sphaeropsis* spores to healthy trees by shearing tools.
- Plant red pine on the best sites. These trees will be more vigorous and their wounds will heal more quickly, reducing the chance for *Sphaeropsis* infection. If infection does occur, the impact of the fungus infection will not be as great as on a stressed tree.

Technical References

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Figure 26

Figure 27

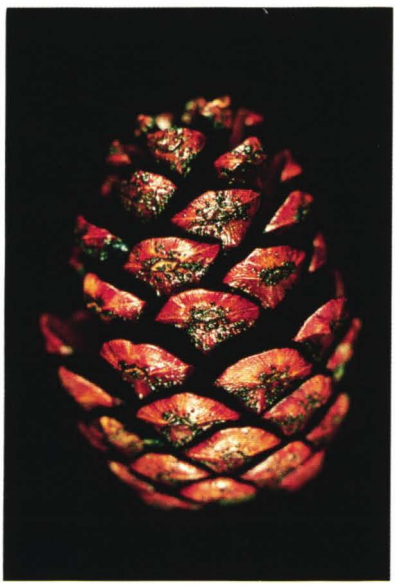

Figure 28

OTHER DISEASES OF RED PINE

Forest managers should also be aware of some other diseases that strike red pine in the Lake States.

Cylindrocladium root rot can be a serious problem in forest nurseries, especially in transplanted stock (fig. 29). It is not a problem in field-planted red pine. There is little danger of contaminating field soil from outplanting infected seedlings because *Cylindrocladium* cannot compete with natural soil microflora.

Figure 29

The fungus, *Heterobasidion annosum* (formerly *Fomes annosus*), causes a root and butt rot of several species of conifers in the eastern United States and is a major disease of southern pines (fig. 30). It has been found on red pine in a few areas in Ontario and southern Michigan. This fungus usually enters a healthy stand by infecting freshly cut stump surfaces, which make this root rot a problem primarily in thinned pine plantations (Robbins 1984). Fruiting bodies are frequently found at the base of infected trees (fig. 31). Climatic factors may prevent this disease from becoming an important problem in the Lake States, but it should be monitored as more of our red pine stands are thinned.

Figure 30

Figure 31

Figure 32

Inonotus tomentosus (formerly *Polyporus tomentosus*) (fig. 32) and *Phellinus pini* (formerly *Fomes pini*) (fig. 33) cause trunk rot mainly in mature red pine stands. This problem is usually of minor importance because most stands are harvested before these diseases cause economic losses.

RED PINE PEST DIAGNOSIS AND CONTROL

Identifying potential pest problems should be a part of any good forest management program designed to prevent or minimize economic losses due to pests. One of the major tasks for forest managers is to gather all the information that will help them distinguish between symptoms caused by diseases, insects, and abiotic factors. Once they positively identify a pest problem, forest managers must determine what kind of losses might be expected and what control alternatives are available to prevent or minimize losses.

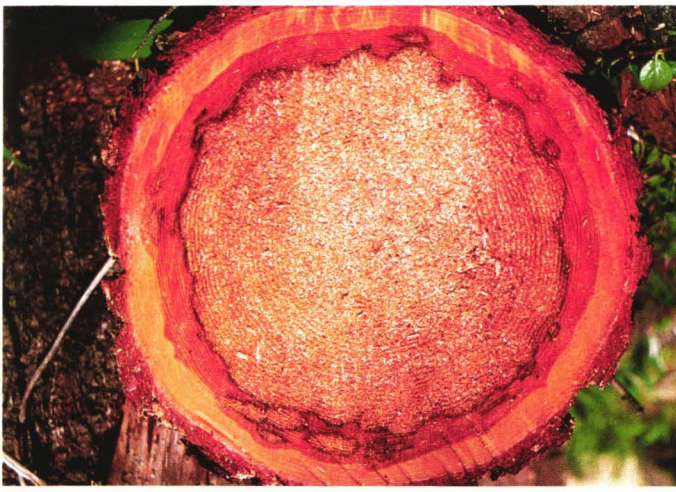

Figure 33

GENERAL GUIDELINES FOR RED PINE PEST MANAGEMENT

Because red pine is one of our most valuable species, forest managers must consider potential pest problems in their forest management planning in order to prevent economic losses. Proper planning at the beginning of a red pine planting project will result in a productive, healthy stand (fig. 34). Palmer and Jones (1983) have developed useful pest management guidelines. Here are some general guidelines to help forest managers prevent or reduce pest problems in red pine:

1. Plant on proper sites to maintain tree vigor. Highest productivity occurs on sandy to loamy soils with good moisture and drainage. Good site preparation before planting and periodic silvicultural treatments after planting are often required to maintain healthy trees.

2. Before seeding or planting, check to see what diseases or insects will or might cause a problem for the trees in the area and develop an integrated pest management action plan to deal quickly with important pest problems that develop. If serious red pine pests are present in or near the planting area and controls are not economically feasible or available, do not plant red pine, especially on poor sites. Another species may be preferable.

3. Survey plantations annually to detect pest problems early. Surveys should be included in the annual program of work, and the procedures should be well developed before surveys are initiated.

4. Report pest problems immediately to your forest pest control personnel for evaluation. Correct pest identification is essential for control. Determine and use available controls for problems serious enough to cause economic losses.

5. Maintain a well-balanced diversity of species on land management units to temper disease or insect outbreaks. Large continuous stands of red pine of the same age are susceptible to severe pest outbreaks, so blocks of red pine should be of varying age classes and broken up with alternate species, preferably not pine. Plantation design is critical for

managers commited to the integrated management approach. Having representatives from critical disciplines (i.e. game managers, plant pathologists, entomologists, landscape designers) review a design before planting can help in the overall management and protection of the land resource. This will also enhance the aesthetics of an area (Sloan 1983).

Figure 34

CONCLUSION

To successfully prevent or control pests of red pine, forest managers must be familiar with those pests and their economic importance, distribution, biology, and controls. Injury caused by insects, diseases, and abiotic factors is often difficult to diagnose. Therefore, accurate and timely identification is essential so that economical and effective integrated pest management strategies can be implemented to protect our valuable red pine resource.

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